EPA REGION 10 - UNDERGROUND INJECTION CONTROL PROGRAM

Class V Shallow Injection Well Fact Sheet
K. Lemieux - No. 2
8/13/98

Large Capacity Onsite Sewage Systems and their Impacts on Ground Water Quality

Large Capacity On-site Sewage Systems (LCOSSs) are designed to treat and dispose of domestic wastewater from facilities which serve 20 or more persons per day. Due to the potential for ground water contamination from these systems, LCOSSs are regulated by the EPA or the appropriate State Underground Injection Control (UIC) Primacy Program as Class V injection wells. These systems usually serve rural communities or isolated establishments as a means of disposing of domestic or household sanitary waste. Establishments may include campgrounds, resorts, multi-family housing, mobile home parks, rural schools, and gas stations (1). The potential impact that LCOSSs have on ground water quality can be greater than smaller domestic systems since LCOSSs serve a variety of different types of facilities. This can lead to a higher degree of variability of disposal practices and contaminant types which contain higher wastewater effluent concentrations, and exhibit higher hydraulic loadings.

Basic Functions of Wastewater Treatment

Large capacity disposal systems are designed like smaller individual systems in terms of components and methods of treatment. The first component is generally a septic tank or other similar treatment process (sand filter, etc.). Its primary purpose is to remove solids from the waste stream to produce a “clarified” liquid, called effluent. The effluent is then discharged to a distribution box or some other collection system that distributes it to the final stage, the soil absorption field for further treatment and disposal. The level of treatment in the soil absorption field depends largely on the type of soil and its unsaturated thickness. Generally, at least a few feet of relatively fine-grained soil with some clay minerals and organic matter are needed to provide adequate treatment.

Impacts on Ground Water Quality

Characteristics of the wastewater effluent can vary greatly, depending on the establishment. Most wastewater from domestic sources includes nitrates, phosphates, bacteria, viruses, and organic compounds. Contaminants such as nitrates, pathogenic bacteria and viruses are of most concern because they are commonly found to contaminate ground water. In locations where nitrate concentrations in ground water exceed the Maximum Contaminant Level (MCL) of 10 mg/L, consumption of the water can cause a condition in infants called methemoglobinemia which, left untreated, can lead to death. Nitrate has also been linked to form N-nitrosamines in the body which have been suspected to cause cancer (3). Ground water contaminated with bacteria such as E. Coli, and Legionella pneumophila and viruses such as hepatitis A, Poliomyelitis, and Coxsackie can cause illnesses ranging from simple gastrointestinal illnesses to severe organ damage, and paralysis (2).

Improper disposal of organic solvents, e.g.,Trichloroethylene, and heavy metals can also be a problem where garage bay shop sinks or floor drains are plumbed into the LCOSS. Solvents and heavy metals that are disposed of using a LCOSS pose a significant risk to human health and the environment and are therefore regulated as industrial injection wells under the UIC Program.

Concentration of effluent- Onsite sewage systems depend highly on dilution from rainfall to attenuate contaminants such as nitrates before they percolate into ground water. This dilution factor lowers the total concentration of contaminant that may be introduced into the aquifer and the facility's ground water supply. The dilution of various contaminants within the aquifer depend on the specific characteristics of the aquifer such as, hydraulic gradient, hydraulic conductivity, and mixing zone thickness. In a rural setting, dilution from annual precipitation can be an effective tool in reducing contaminant loadings to ground water, provided that a large undeveloped area surrounds the single onsite sewage disposal system. However, in a more urban or suburban setting, decreasing the ground water recharge zone, i.e., undeveloped area, and increasing the number of onsite sewage systems, i.e., increasing sewage system densities, significantly threatens the quality of the ground water and increases the potential for public health impacts (4).

Establishments may further impact ground water quality by increasing the number of occupants without increasing the size of the absorption field. Concentrations of contaminants, such as nitrogen, entering the absorption field are increased as a result. Since 55-85% of the nitrogen that enters the septic tank is available to ground water mainly in the form of nitrates, the concentration of nitrogen in the effluent becomes very important in determining how much nitrates reach the ground water (2). This can lead to localized levels of nitrate exceeding the MCL. Pathogenic bacteria and viruses are also more likely to be in effluent when more people are using the system.

Hydraulic overloading- LCOSSs can also have a wide range of wastewater volumes entering the soil absorption field. Peak flows can occur seasonally or daily, potentially overloading a system within a short period of time. When there is already a concern of a higher concentration of effluent as a result of overloading, the volume of water entering the system can also be a problem. When the system is overloaded, the soil becomes saturated and minimal if any treatment occurs. The effluent may either move quickly through the soils or reach land surface and begin ponding. In sandy soils, overloading increases the rate of pathogenic organisms reaching the ground water and decreases adequate treatment of nitrogen. Less retention time in the soil allows more bacteria to reach ground water before they die off and nitrogen moves quickly to ground water entering as nitrates or in its non-oxidized form of ammonium ion (NH_4^+) and ammonia (NH_3) (2). Again, localized contamination of the ground water can occur, posing a threat to nearby residents. Hydraulic overloading can be prevented if the system is properly sited in soil that has adequate soil absorption capacity and proper dosing techniques are designed into the system. Dosing helps distribute the wastewater evenly throughout the day rather than in large amounts over a short period of time. Alternating soil absorption fields may also decrease hydraulic overloading and increase the efficiency of the LCOSS.

Disposal practices and septic system maintenance - Depending on the establishment, improper disposal or operation of the system is of concern. Sinks with drains in garages can introduce solvents, oils, and grease into a sewage system, potentially damaging the disposal field, limiting its ability to treat the wastewater. In the worst case they can reach the ground water, exposing water users in the area to potentially harmful levels of industrial chemicals.

In order to reduce or prevent contaminants from reaching the ground water, large capacity systems need to be properly designed as well as operated and maintained. Design includes siting the system, as well as sizing and choosing the appropriate equipment and processes to adequately treat the wastewater. Proper siting involves choosing soil conditions and sites that are appropriately separated from ground water to minimize impacts. Proper sizing involves taking into account the capacity of the system needed and the appropriate size of the disposal field. This is most important in minimizing the concentrations, and preventing hydraulic overloading. Finally, proper use and maintenance of the system are the best ways to assure that ground water and human health are protected from the potentially harmful effects of a LCOSS.

References

1. EPA ; Large- Capacity Septic System Guide; March 1997

2. M. H. Stoltz and R. B. Reneau, Jr.,"Potential for Contamination of Ground and Surface Waters from On-site Wastewater Disposal Systems"

3. North Carolina Cooperative Extension Service; " Sources and Extent of Groundwater Contamination" Water Quality and Waste Management; 1996 http://www.owr.ehnr.state.nc.us/ref/00065.htm

4. Bauman and Schafer; "Estimating Ground-Water Quality Impacts From On-site Sewage Treatment Systems"; ASAE 07-85 - Fourth Annual Symposium on Individual and small Community Sewage Systems; Dec. 10-11, 1984; 285-294

For more information regarding the UIC Program and regulation of Large Capacity Onsite Sewage Systems please contact:

Alaska
Jonathan Williams
Ground Water Protection Unit, OW-137
U.S. EPA Region 10
1200 Sixth Avenue
Seattle, Washington 98101
(206) 553-1369
williams.jonathan@epa.gov

Idaho
Mike Piechowski
or Mark Slifka
Idaho Department of Water Resources
1301 North Orchard Street
Boise, Idaho 83706
(208) 327-7956
mpiechow@idwr.state.id.us

Oregon
Barbara Priest
Oregon Department of Environmental Quality
811 S.W. Sixth Avenue
Portland, Oregon 97204
(503) 229-5945
priest.barbara@deq.state.or.us

Washington
Mary Shaleen Hansen
Washington Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600
(360) 407-6143
maha461@ecy.wa.gov

Indian Country
Jeff KenKnight
Ground Water Protection Unit, OW-137
U.S. EPA Region 10
1200 Sixth Avenue
Seattle, Washington 98101
(206) 553-0226
kenknight.jeff@epa.gov

ID, OR, WA State UIC Primacy Program Liaison
Calvin Terada
Ground Water Protection Unit, OW-137
U.S. EPA Region 10
1200 Sixth Avenue
Seattle, Washington 98101
(206) 553-4141
terada.calvin@epa.gov